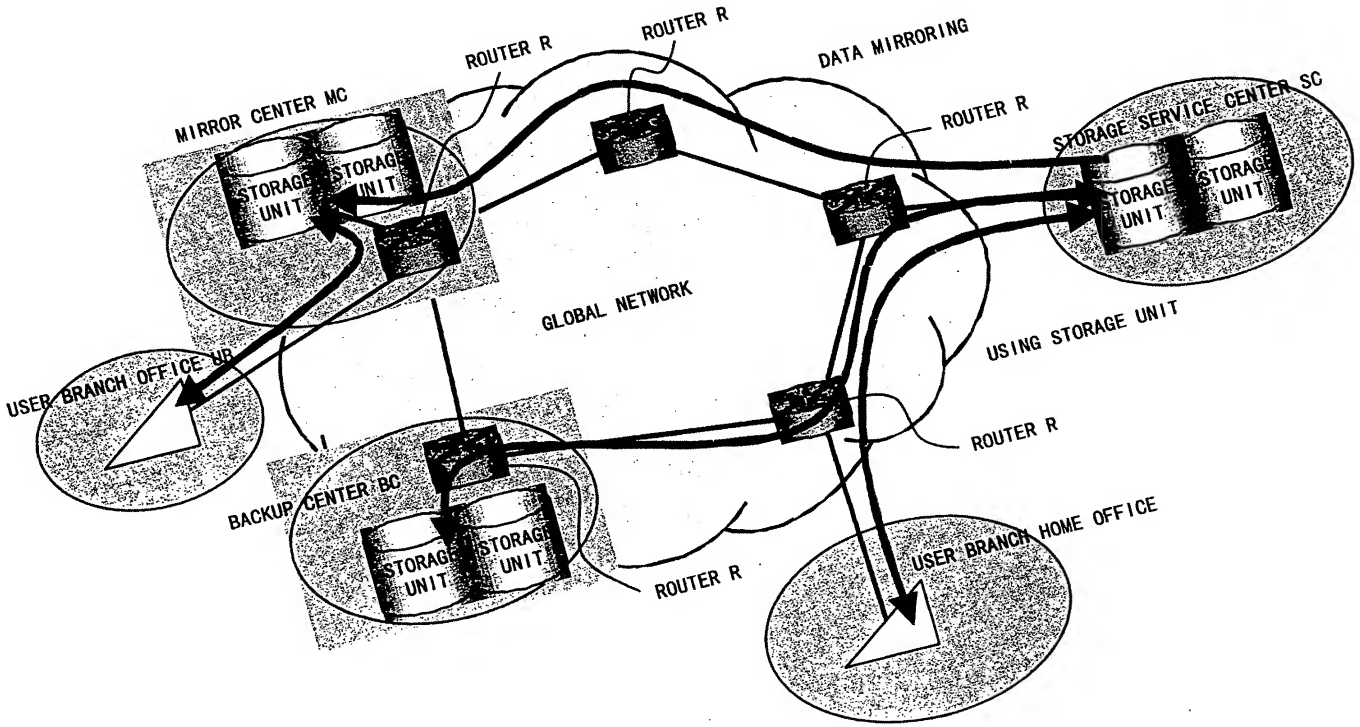

FIG. 1
RELATED ART

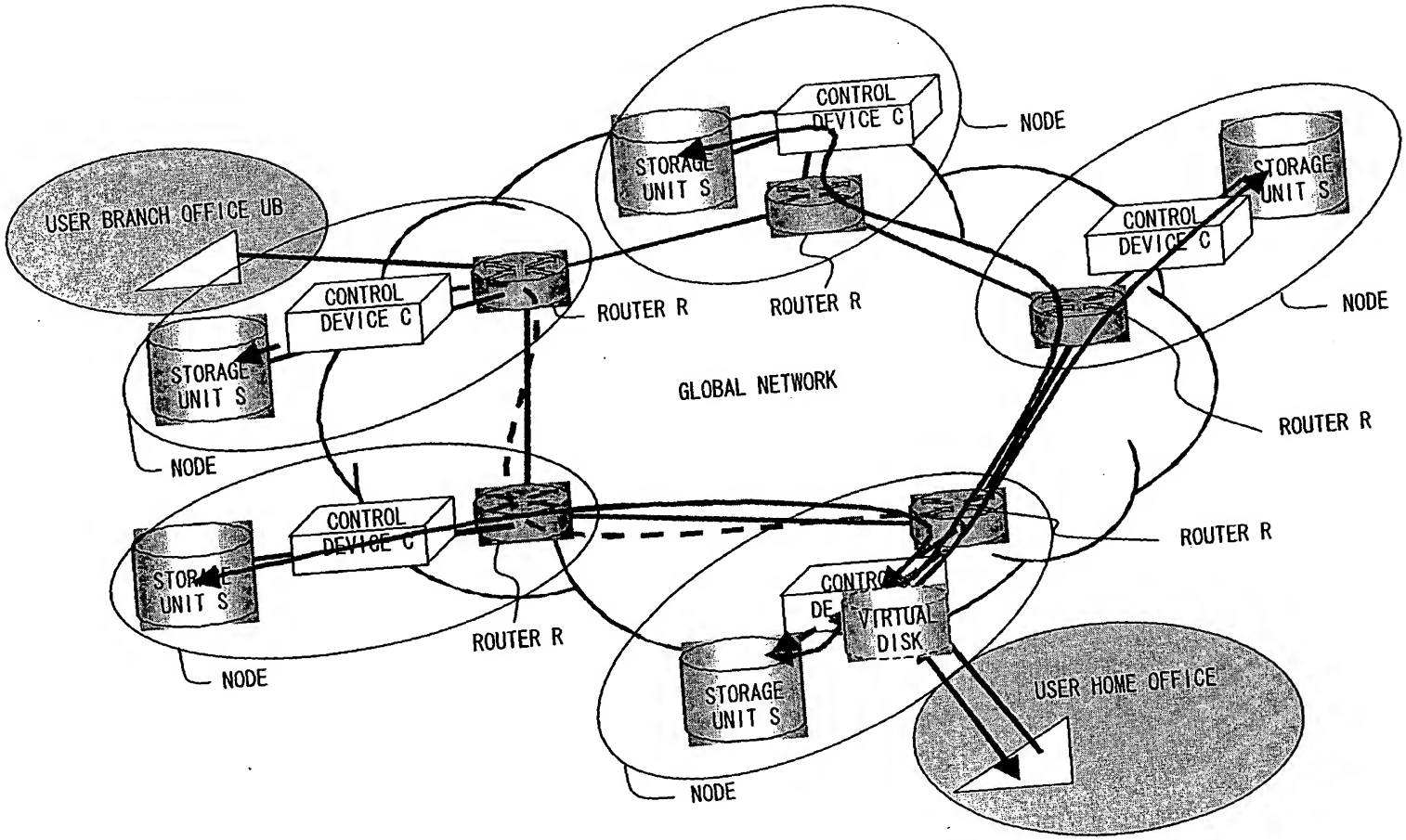
USER BRANCH OFFICE UB
CONTROL DEVICE C
STORAGE UNIT S
NODE
ROUTER R
GLOBAL NETWORK
VIRTUAL DISK
USER HOME OFFICE

FIG. 2

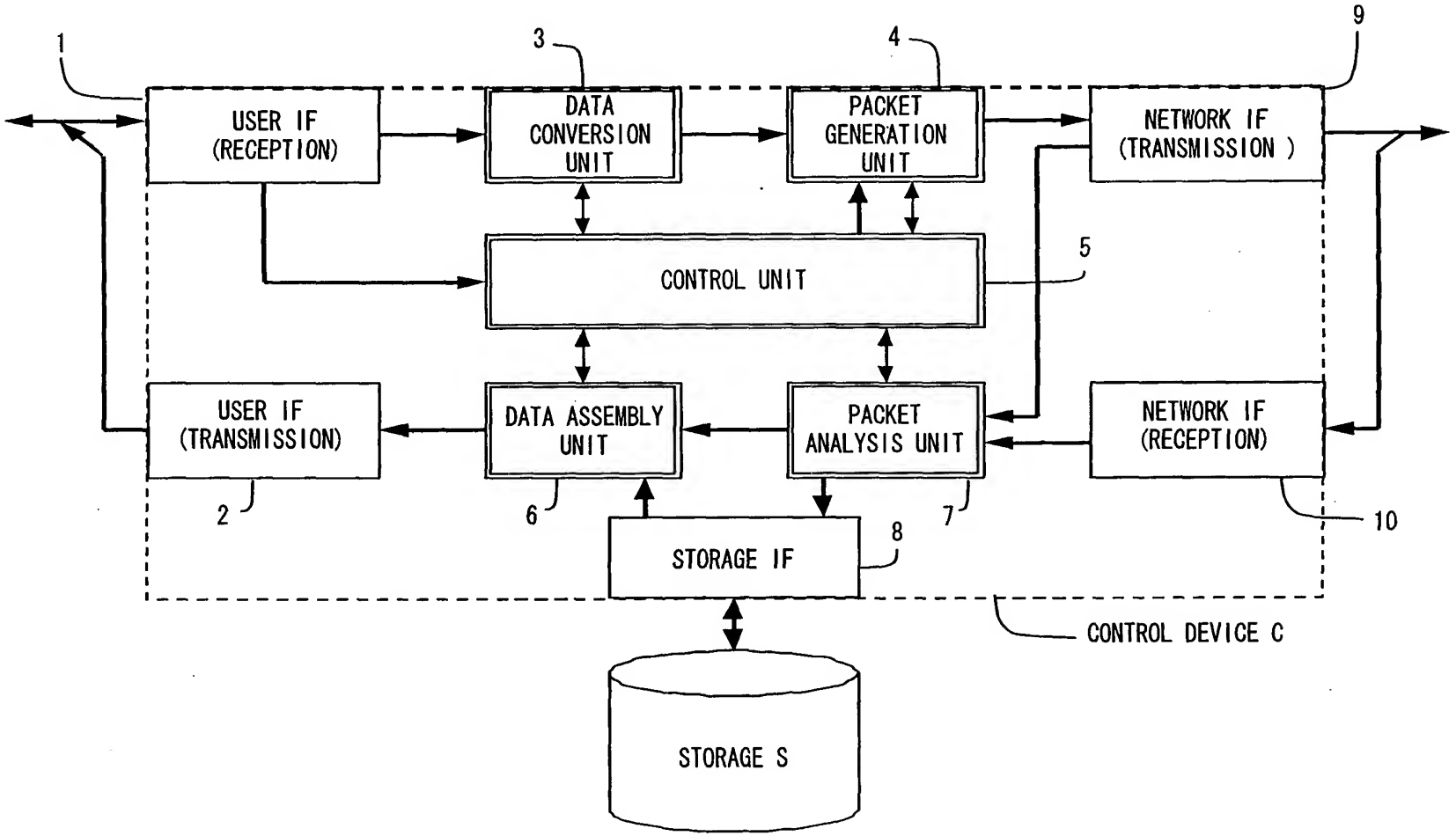
1
3
4
9
USER IF (RECEPTION)
DATA CONVERSION UNIT
PACKET GENERATION UNIT
NETWORK IF (TRANSMISSION)
CONTROL UNIT
5
USER IF (TRANSMISSION)
DATA ASSEMBLY UNIT
PACKET ANALYSIS UNIT
NETWORK IF (RECEPTION)
2
6
7
10
8
STORAGE IF
CONTROL DEVICE C
STORAGE S

FIG. 3

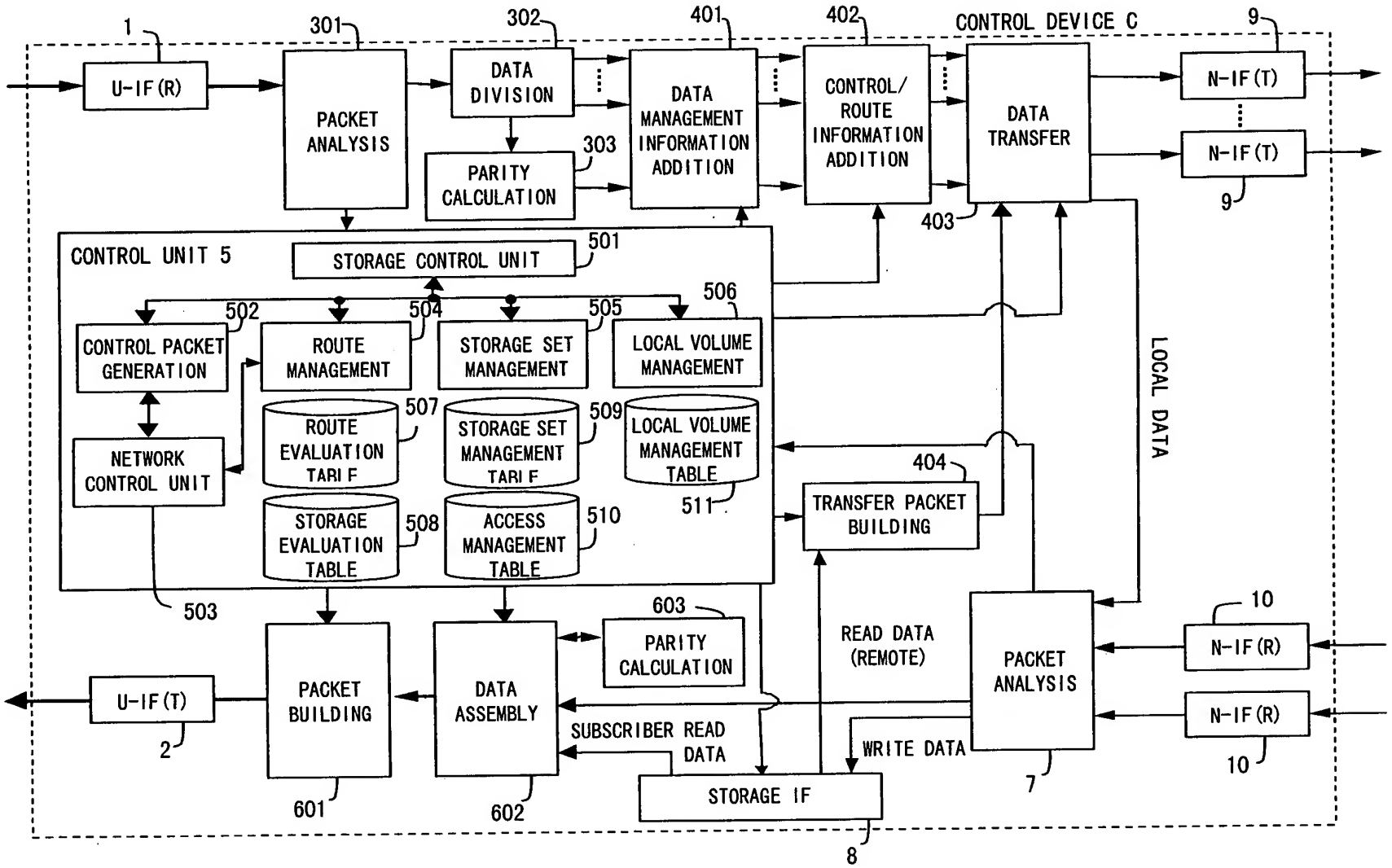
CONTROL DEVICE C
1
U-IF(R)
301
PACKET ANALYSIS
302
DATA DIVISION
303
PARITY CALCULATION
401
DATA MANAGEMENT INFORMATION ADDITION
402
CONTROL/ ROUTE INFORMATION ADDITION
403
DATA TRANSFER
9
N-IF(T)
N-IF(T)
9
CONTROL UNIT 5
501
STORAGE CONTROL UNIT
502
CONTROL PACKET GENERATION
504
ROUTE MANAGEMENT
505
STORAGE SET MANAGEMENT
506
LOCAL VOLUME MANAGEMENT
NETWORK CONTROL UNIT
507
ROUTE EVALUATION TABLE
509
STORAGE SET MANAGEMENT TABLE
511
LOCAL VOLUME MANAGEMENT TABLE
508
STORAGE EVALUATION TABLE
510
ACCESS MANAGEMENT TABLE
503
404
TRANSFER PACKET BUILDING
LOCAL DATA
603
PARITY CALCULATION
READ DATA (REMOTE)
10
N-IF(R)
N-IF(R)
10
PACKET ANALYSIS
7
U-IF(T)
2
PACKET BUILDING
601
DATA ASSEMBLY
602
SUBSCRIBER READ DATA
WRITE DATA
STORAGE IF
8

FIG. 4

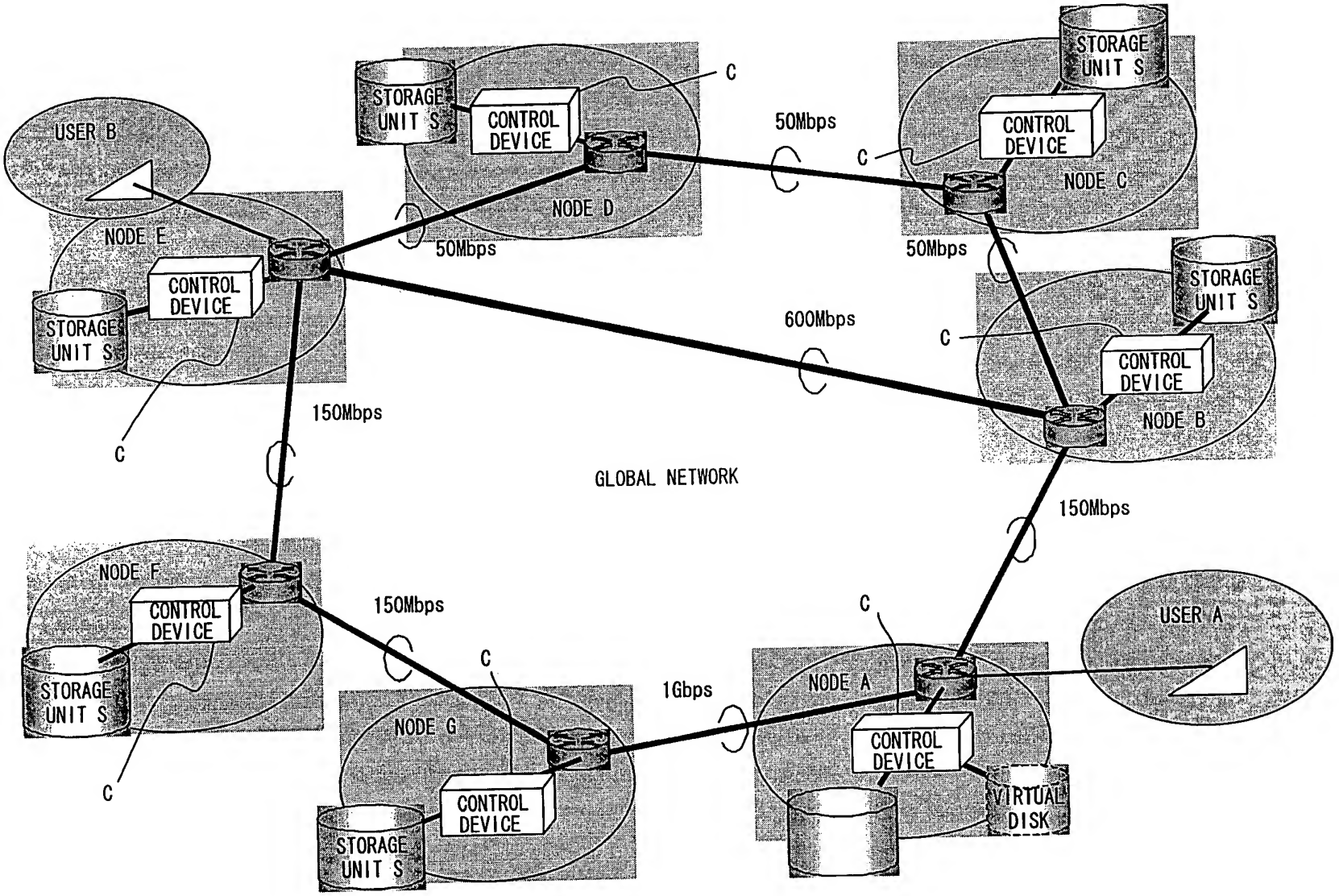
USER B
NODE E
CONTROL DEVICE
STORAGE UNIT S
C
STORAGE UNIT S
CONTROL DEVICE
NODE D
C
50Mbps
50Mbps
STORAGE UNIT S
CONTROL DEVICE
NODE C
C
50Mbps
600Mbps
STORAGE UNIT S
CONTROL DEVICE
NODE B
C
150Mbps
GLOBAL NETWORK
150Mbps
NODE F
CONTROL DEVICE
STORAGE UNIT S
C
150Mbps
C
NODE G
CONTROL DEVICE
STORAGE UNIT S
1Gbps
C
NODE A
CONTROL DEVICE
VIRTUAL DISK
USER A

FIG. 5

SECTION	BANDWIDTH	COST	DISTANCE	USE PRIORITY OF STORAGE UNIT
local	—	—	—	∞
A-B	150	100	80	11
B-C	50	50	150	17
C-D	50	100	200	21
D-E	50	50	150	17
E-F	150	100	100	13
F-G	150	100	80	11
A-G	1000	200	10	11
B-E	600	300	200	24

FIG. 6

NODE	ROUTE	STORAGE EVALUATION VALUE	HOP COUNT
A	local	∞	0
B	A-B	11.0	1
C	A-B-C	9.8	2
D	A-B-C-D	8.8	3
	A-B-E-D	9.6	3
E	A-B-E	11.5	2
F	A-G-F	8.3	2
G	A-G	11.0	1

FIG. 7

STORAGE SET NUMBER	PROPERTY																								
	WHOLE			NODE A			NODE B			NODE C			NODE D			NODE E			NODE F			NODE G		
	READ	WRITE	STATE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE	DIVISION	ORIGINAL	USE
00000001	3	4	G	1	O	RW	3	O	RW	2	O	-W				0	O	RW				2	C	R
00000002	3	3	G	2	O	RW				1	O	RW	0	O	RW									
00000003	4	5	R	0	O	RW	1	O	RW	4	O	RW	3	O	RW	2	O	-W						
00000004	2	3	G			RW	2	O		0	O	-W				1	O	RW						

FIG. 8

STORAGE SET NUMBER	000010001
STORAGE SET ACCESS NUMBER	PROPERTY
00000001	RWLO
00000002	RWLO
00000003	-W-O
00000004	-W-O
00000005	---O
00000006	-W-O

FIG. 9

LOCAL STORAGE UNIT		STORAGE SET MANAGEMENT INFORMATION	
STORAGE ACCESS NUMBER	PROPERTY	STORAGE SET MANAGEMENT NUMBER	STORAGE SET ACCESS NUMBER
00000001	RWL	00010021	00040001
00000002	RW-	02003001	00040004
00000003	RW-	00000000	00000000
00000004	R-F	01002111	01000100
00000005	RW-	00010021	00001562
00000006	RW-	00010021	00001563

FIG. 10

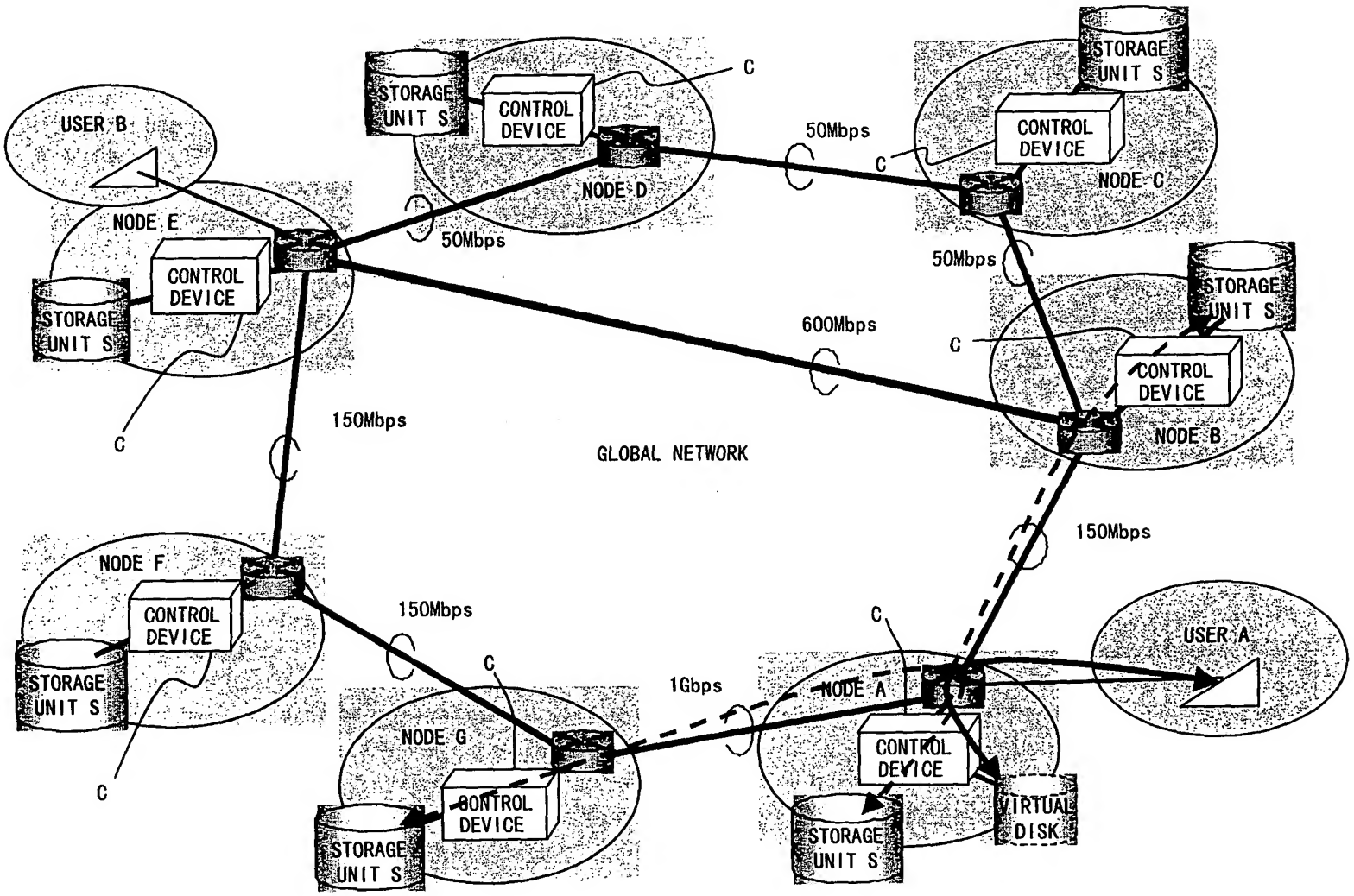
USER B
NODE E
CONTROL DEVICE
STORAGE UNIT S
C
STORAGE UNIT S
CONTROL DEVICE
NODE D
C
50Mbps
STORAGE UNIT S
CONTROL DEVICE
NODE C
C
50Mbps
50Mbps
600Mbps
STORAGE UNIT S
C
CONTROL DEVICE
NODE B
150Mbps
GLOBAL NETWORK
150Mbps
NODE F
CONTROL DEVICE
STORAGE UNIT S
C
150Mbps
C
NODE G
CONTROL DEVICE
STORAGE UNIT S
1Gbps
C
NODE A
USER A
CONTROL DEVICE
STORAGE UNIT S
VIRTUAL DISK

FIG. 11

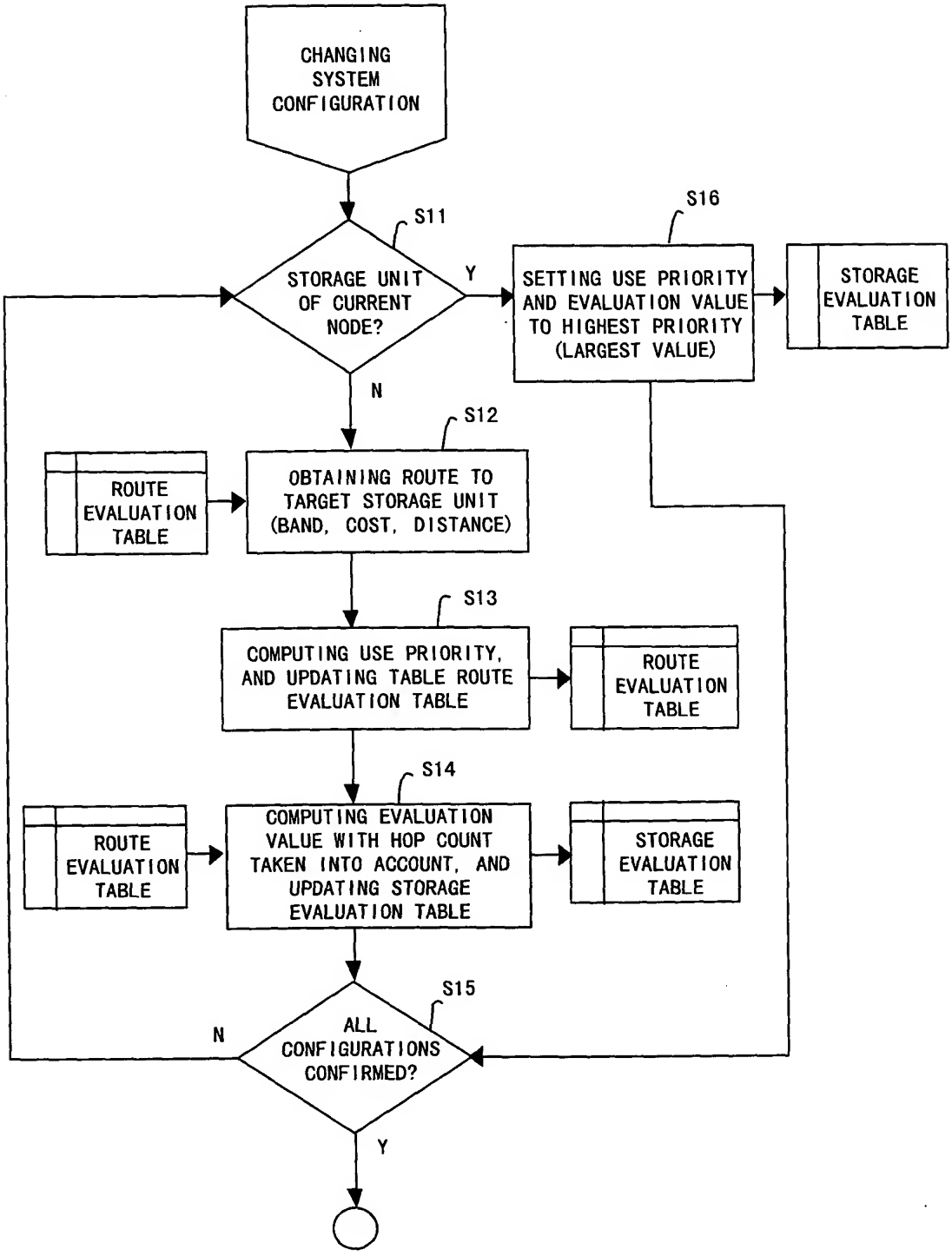
CHANGING SYSTEM CONFIGURATION
S11
STORAGE UNIT OF CURRENT NODE?
Y
N
S16
SETTING USE PRIORITY AND EVALUATION VALUE TO HIGHEST PRIORITY (LARGEST VALUE)
STORAGE EVALUATION TABLE
S12
ROUTE EVALUATION TABLE
OBTAINING ROUTE TO TARGET STORAGE UNIT (BAND, COST, DISTANCE)
S13
COMPUTING USE PRIORITY, AND UPDATING TABLE ROUTE EVALUATION TABLE
ROUTE EVALUATION TABLE
S14
ROUTE EVALUATION TABLE
COMPUTING EVALUATION VALUE WITH HOP COUNT TAKEN INTO ACCOUNT, AND UPDATING STORAGE EVALUATION TABLE
STORAGE EVALUATION TABLE
S15
N
ALL CONFIGURATIONS CONFIRMED?
Y

FIG. 12

ROUTE EVALUATION TABLE

SECTION	BANDWIDTH	COST	DISTANCE	USE PRIORITY OF SECTION	USE PRIORITY OF STORAGE UNIT
local	—	—	—	∞	∞
A-B	150	100	80	3	11
B-C	50	50	150	2	17
C-D	50	100	200	1	21
D-E	50	50	150	2	17
E-F	150	100	100	3	13
F-G	150	100	80	3	11
A-G	1000	200	10	10	11
B-E	600	300	200	4	24

FIG. 13A

STORAGE EVALUATION TABLE

NODE	ROUTE	ROUTE EVALUATION VALUE	STORAGE EVALUATION VALUE	HOP COUNT
A	local	∞	∞	0
B	A-B	3	11.0	1
C	A-B-C	2.5	9.8	2
D	A-B-C-D	2	8.8	3
	A-B-E-D	3	9.6	3
E	A-B-E	3.5	11.5	2
F	A-G-F	6.5	8.3	2
G	A-G	10	11.0	1

FIG. 13B

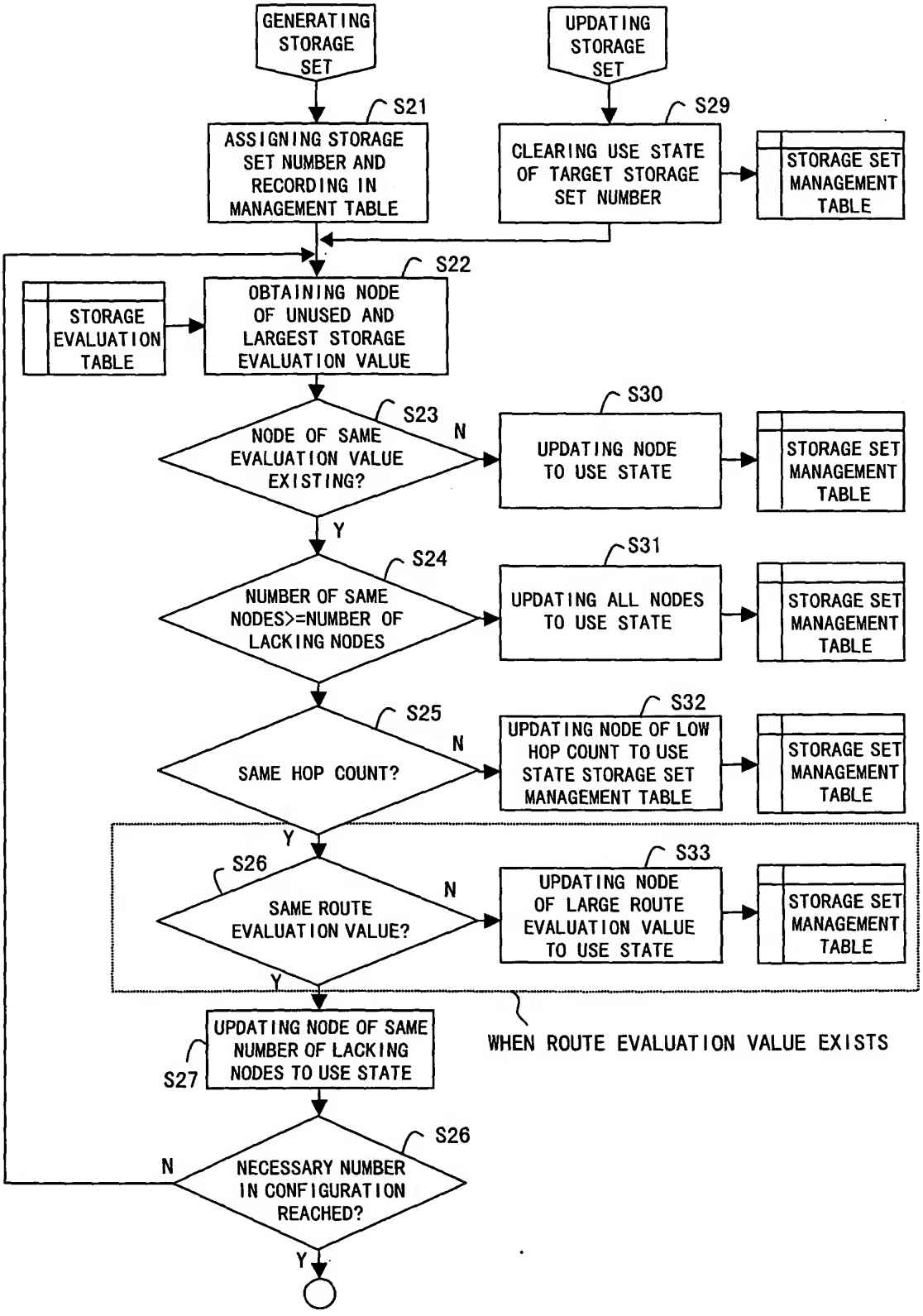
GENERATING STORAGE SET
UPDATING STORAGE SET
S21
ASSIGNING STORAGE SET NUMBER AND RECORDING IN MANAGEMENT TABLE
S29
CLEARING USE STATE OF TARGET STORAGE SET NUMBER
STORAGE SET MANAGEMENT TABLE
S22
STORAGE EVALUATION TABLE
OBTAINING NODE OF UNUSED AND LARGEST STORAGE EVALUATION VALUE
S23
NODE OF SAME EVALUATION VALUE EXISTING?
N
S30
UPDATING NODE TO USE STATE
STORAGE SET MANAGEMENT TABLE
Y
S24
NUMBER OF SAME NODES>=NUMBER OF LACKING NODES
S31
UPDATING ALL NODES TO USE STATE
STORAGE SET MANAGEMENT TABLE
S25
SAME HOP COUNT?
N
S32
UPDATING NODE OF LOW HOP COUNT TO USE STATE STORAGE SET MANAGEMENT TABLE
STORAGE SET MANAGEMENT TABLE
Y
S26
SAME ROUTE EVALUATION VALUE?
N
S33
UPDATING NODE OF LARGE ROUTE EVALUATION VALUE TO USE STATE
STORAGE SET MANAGEMENT TABLE
Y
WHEN ROUTE EVALUATION VALUE EXISTS
S27
UPDATING NODE OF SAME NUMBER OF LACKING NODES TO USE STATE
S26
N
NECESSARY NUMBER IN CONFIGURATION REACHED?
Y

FIG. 14

ROUTE EVALUATION TABLE

SECTION	BANDWIDTH (Mbps)	COST	DISTANCE	USE PRIORITY OF STORAGE UNIT
A-B	150	100	80	11
B-C	50	50	150	17
C-D	50	100	200	21
D-E	50	50	150	17
E-F	150	100	100	13
F-G	150	100	80	11
A-G	1000	200	10	11
B-E	600	300	200	24

FIG. 15A

STORAGE EVALUATION TABLE

NODE	ROUTE	EQUATION	STORAGE EVALUATION VALUE
A			∞
B	A-B	=(A-B)	11.0
C	A-B-C	={(A-B)+0.5(B-C)}/2	9.8
D	A-B-E-D	={(A-B)+0.5(B-E)+0.33(D-E)}/3	9.6
E	A-E-D	={(A-B)+0.5(B-E)}/2	11.5
F	A-G-F	={(A-B)+0.5(F-G)}/2	8.3
G	A-G	=(A-G)	11.0

FIG. 15B

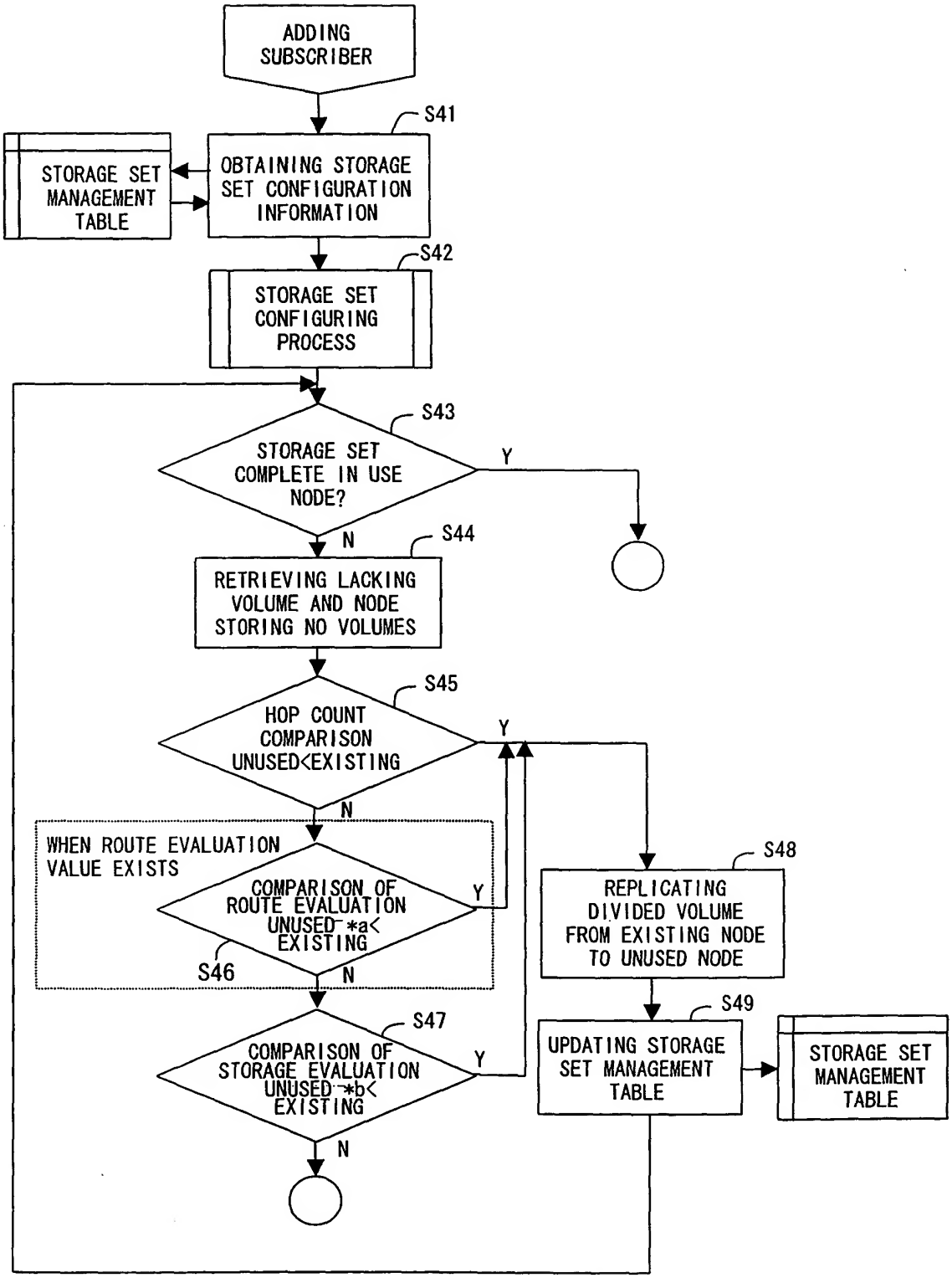
ADDING SUBSCRIBER
S41
OBTAINING STORAGE SET CONFIGURATION INFORMATION
STORAGE SET MANAGEMENT TABLE
S42
STORAGE SET CONFIGURING PROCESS
S43
STORAGE SET COMPLETE IN USE NODE?
Y
N
S44
RETRIEVING LACKING VOLUME AND NODE STORING NO VOLUMES
S45
HOP COUNT COMPARISON UNUSED<EXISTING
Y
N
WHEN ROUTE EVALUATION VALUE EXISTS
COMPARISON OF ROUTE EVALUATION UNUSED *a< EXISTING
Y
S46
N
S47
COMPARISON OF STORAGE EVALUATION UNUSED *b< EXISTING
Y
N
S48
REPLICATING DIVIDED VOLUME FROM EXISTING NODE TO UNUSED NODE
S49
UPDATING STORAGE SET MANAGEMENT TABLE
STORAGE SET MANAGEMENT TABLE

FIG. 16

NODE	USER A			USER E		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	←
B	11.0	1	b	24.0	1	←
C	9.8	2		16.3	2	
D	9.6	3		17.0	1	d'
E	11.5	2	c	∞	0	←
F	8.3	2		13.0	1	
G	11.0	1	d	10.8	2	←

FIG. 17

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	←	11.3	2	←
B	11.0	1	b	24.0	1	←	17.0	1	←
C	10.8	2		16.3	2		∞	0	a'
D	9.1	3		17.0	1	d'	21.0	1	←
E	11.5	2	c	∞	0	←	14.8	2	←
F	8.3	2	a'	13.0	1	←	10.9	3	←
G	11.0	1	d	10.8	2	←	8.4	3	←

FIG. 18

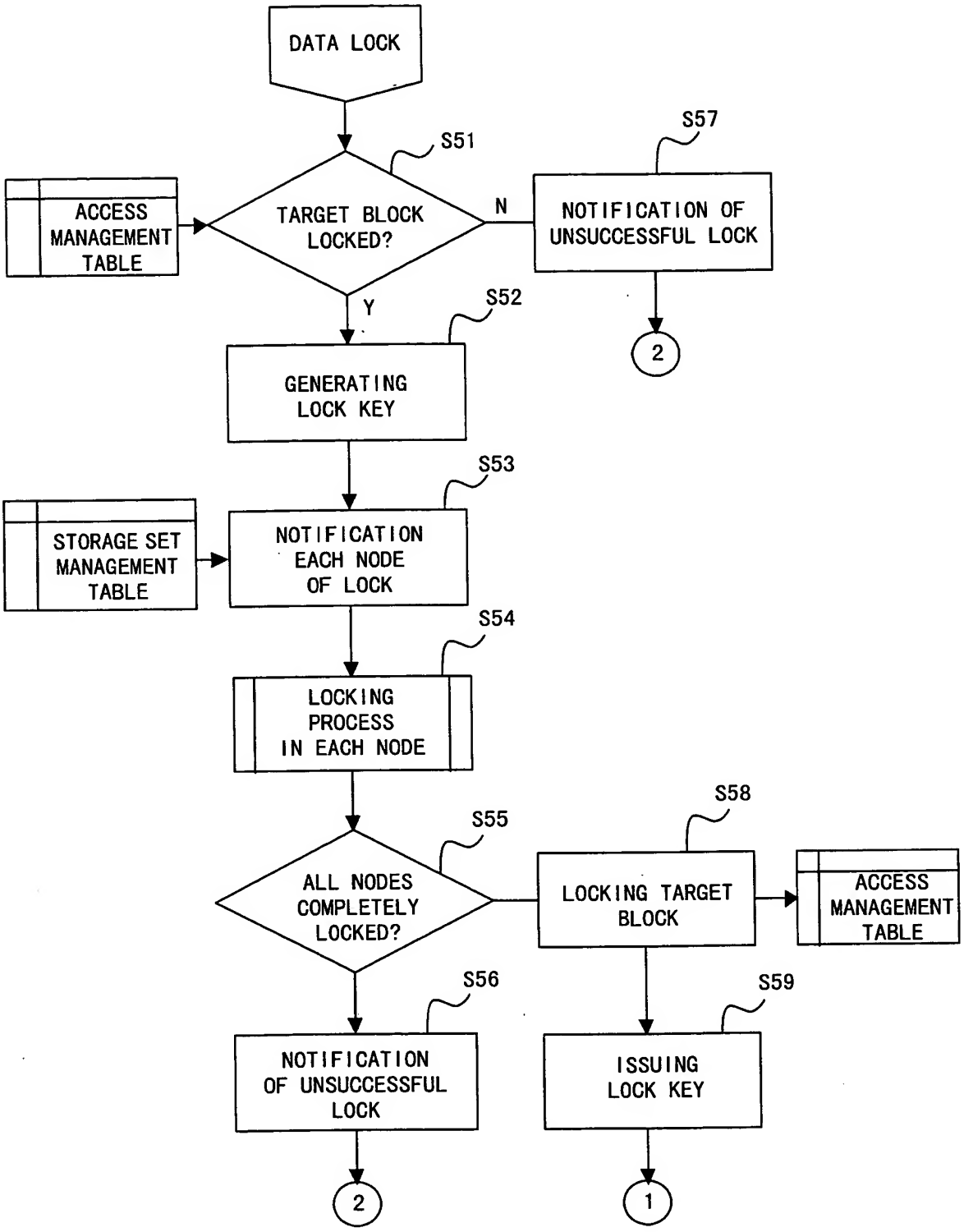
DATA LOCK
S51
TARGET BLOCK LOCKED?
ACCESS MANAGEMENT TABLE
N
S57
NOTIFICATION OF UNSUCCESSFUL LOCK
2
Y
S52
GENERATING LOCK KEY
S53
STORAGE SET MANAGEMENT TABLE
NOTIFICATION EACH NODE OF LOCK
S54
LOCKING PROCESS IN EACH NODE
S55
ALL NODES COMPLETELY LOCKED?
S58
LOCKING TARGET BLOCK
ACCESS MANAGEMENT TABLE
S56
NOTIFICATION OF UNSUCCESSFUL LOCK
S59
ISSUING LOCK KEY
2
1

FIG. 19

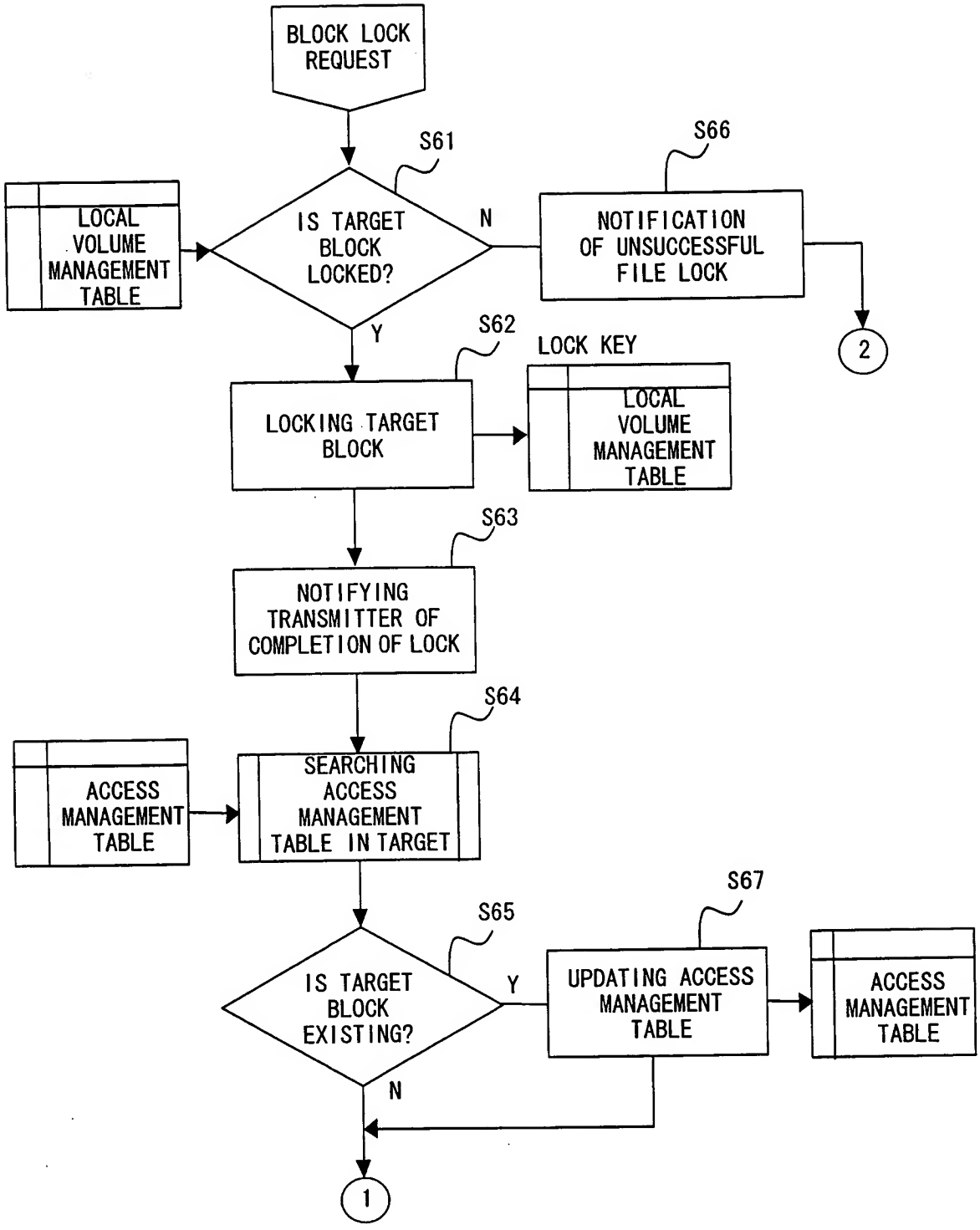
BLOCK LOCK REQUEST
S61
IS TARGET BLOCK LOCKED?
N
Y
LOCAL VOLUME MANAGEMENT TABLE
S66
NOTIFICATION OF UNSUCCESSFUL FILE LOCK
2
S62
LOCK KEY
LOCKING TARGET BLOCK
LOCAL VOLUME MANAGEMENT TABLE
S63
NOTIFYING TRANSMITTER OF COMPLETION OF LOCK
S64
ACCESS MANAGEMENT TABLE
SEARCHING ACCESS MANAGEMENT TABLE IN TARGET
S67
S65
IS TARGET BLOCK EXISTING?
Y
UPDATING ACCESS MANAGEMENT TABLE
ACCESS MANAGEMENT TABLE
N
1

FIG. 20

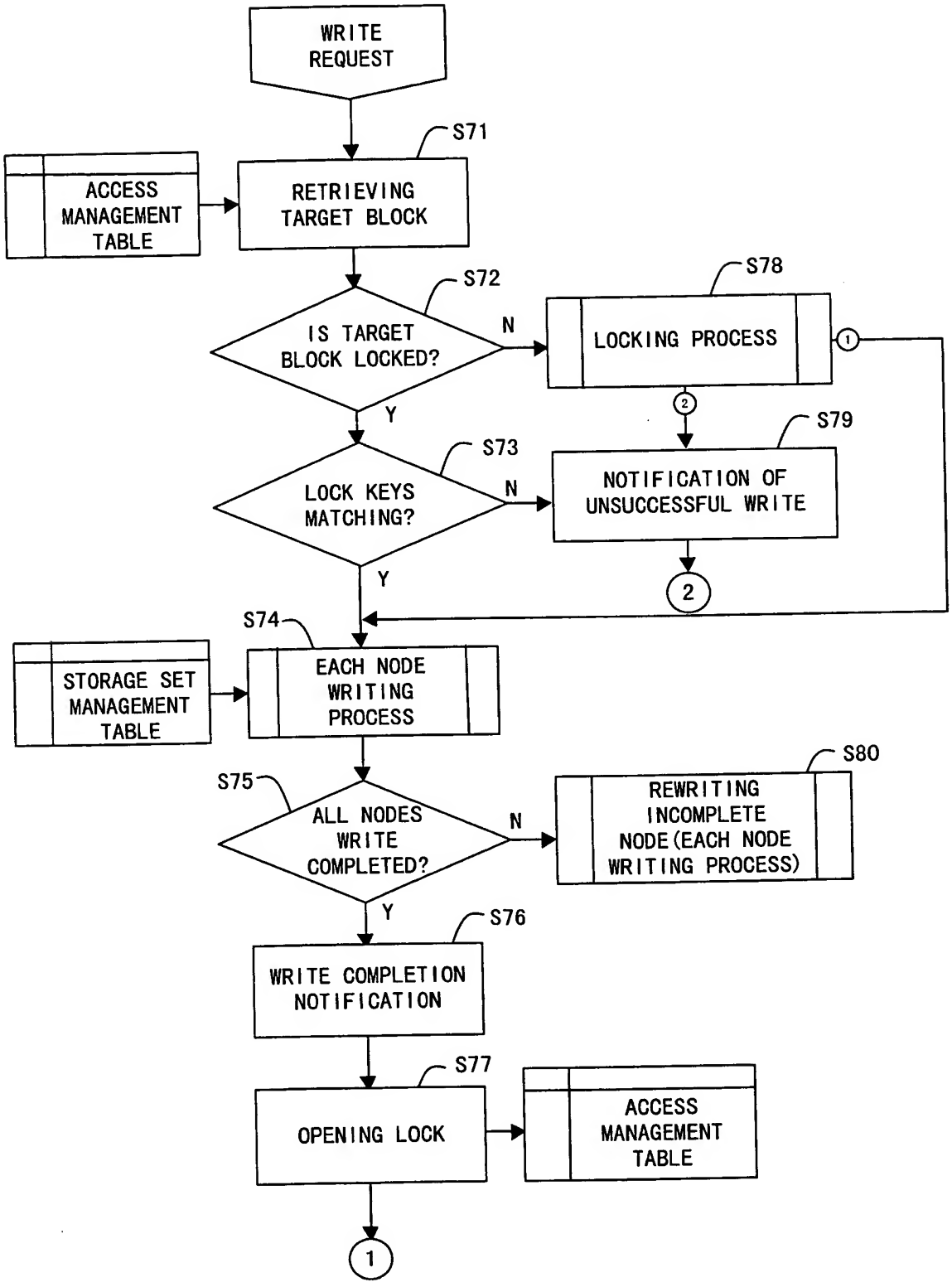
WRITE REQUEST
S71
ACCESS MANAGEMENT TABLE
RETRIEVING TARGET BLOCK
S72
IS TARGET BLOCK LOCKED?
N
Y
S78
LOCKING PROCESS
1
2
S79
S73
LOCK KEYS MATCHING?
N
NOTIFICATION OF UNSUCCESSFUL WRITE
Y
2
S74
STORAGE SET MANAGEMENT TABLE
EACH NODE WRITING PROCESS
S80
S75
ALL NODES WRITE COMPLETED?
N
REWRITING INCOMPLETE NODE (EACH NODE WRITING PROCESS)
Y
S76
WRITE COMPLETION NOTIFICATION
S77
OPENING LOCK
ACCESS MANAGEMENT TABLE
1

FIG. 21

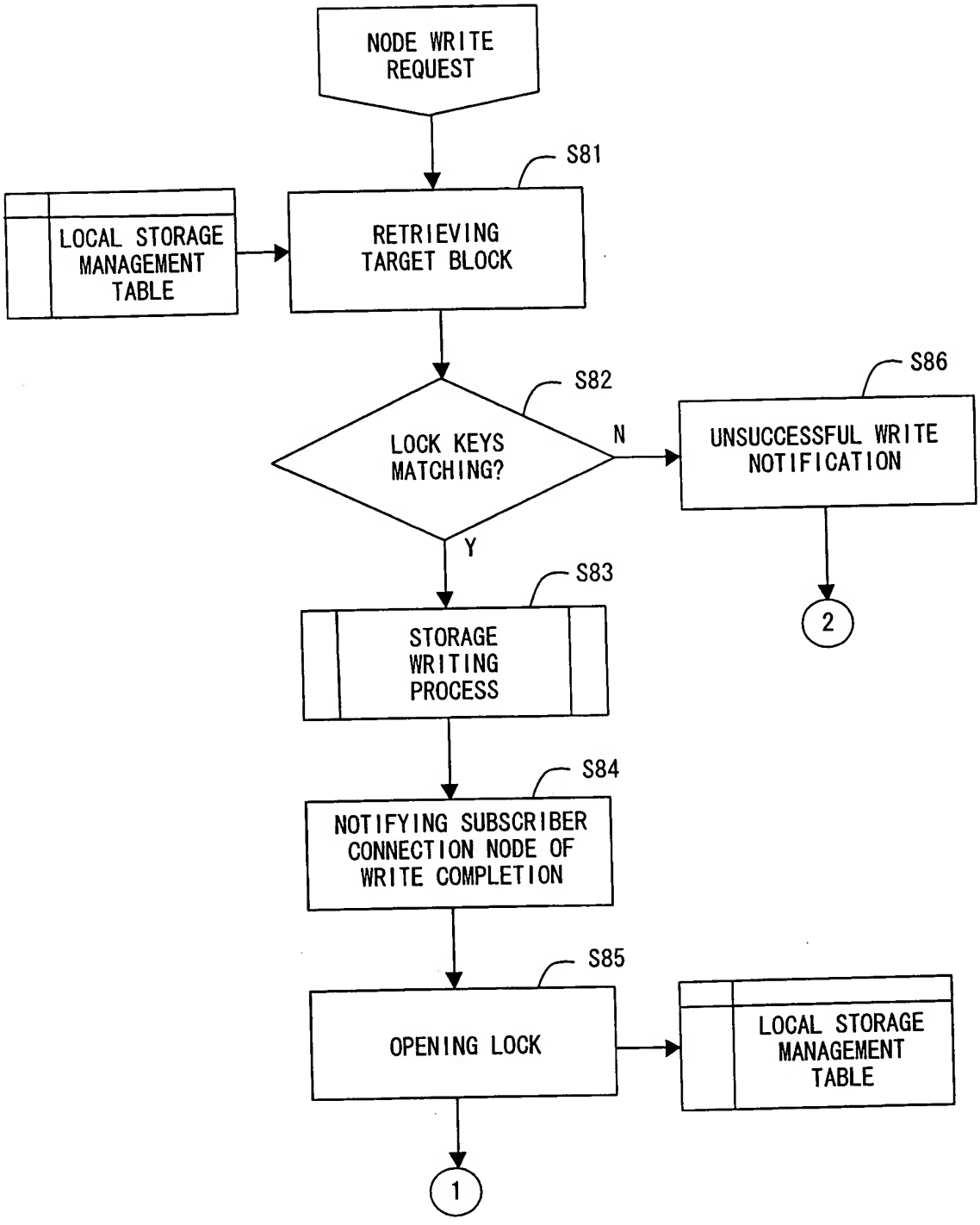
NODE WRITE REQUEST
S81
LOCAL STORAGE MANAGEMENT TABLE
RETRIEVING TARGET BLOCK
S82
LOCK KEYS MATCHING?
N
S86
UNSUCCESSFUL WRITE NOTIFICATION
Y
2
S83
STORAGE WRITING PROCESS
S84
NOTIFYING SUBSCRIBER CONNECTION NODE OF WRITE COMPLETION
S85
OPENING LOCK
LOCAL STORAGE MANAGEMENT TABLE
1

FIG. 22

STORAGE SET NUMBER	000010001	
STORAGE SET ACCESS NUMBER	PROPERTY	LOCK KEY
00000001	RWLO	0111344
00000002	RWLO	1124433
00000003	-W-O	
00000004	-W-O	
00000005	---O	
00000006	-W-O	

FIG. 23A

LOCAL STORAGE			STORAGE SET CONFIGURATION INFORMATION	
STORAGE ACCESS NUMBER	PROPERTY	LOCK KEY	STORAGE SET MANAGEMENT NUMBER	STORAGE SET ACCESS NUMBER
00000001	RWL		00010021	00040001
00000002	RW-	001223	02003001	00040004
00000003	RW-		00000000	00000000
00000004	R-F		01002111	01000100
00000005	RW-		00010021	00001562
00000006	RW-		00010021	00001563

FIG. 23B

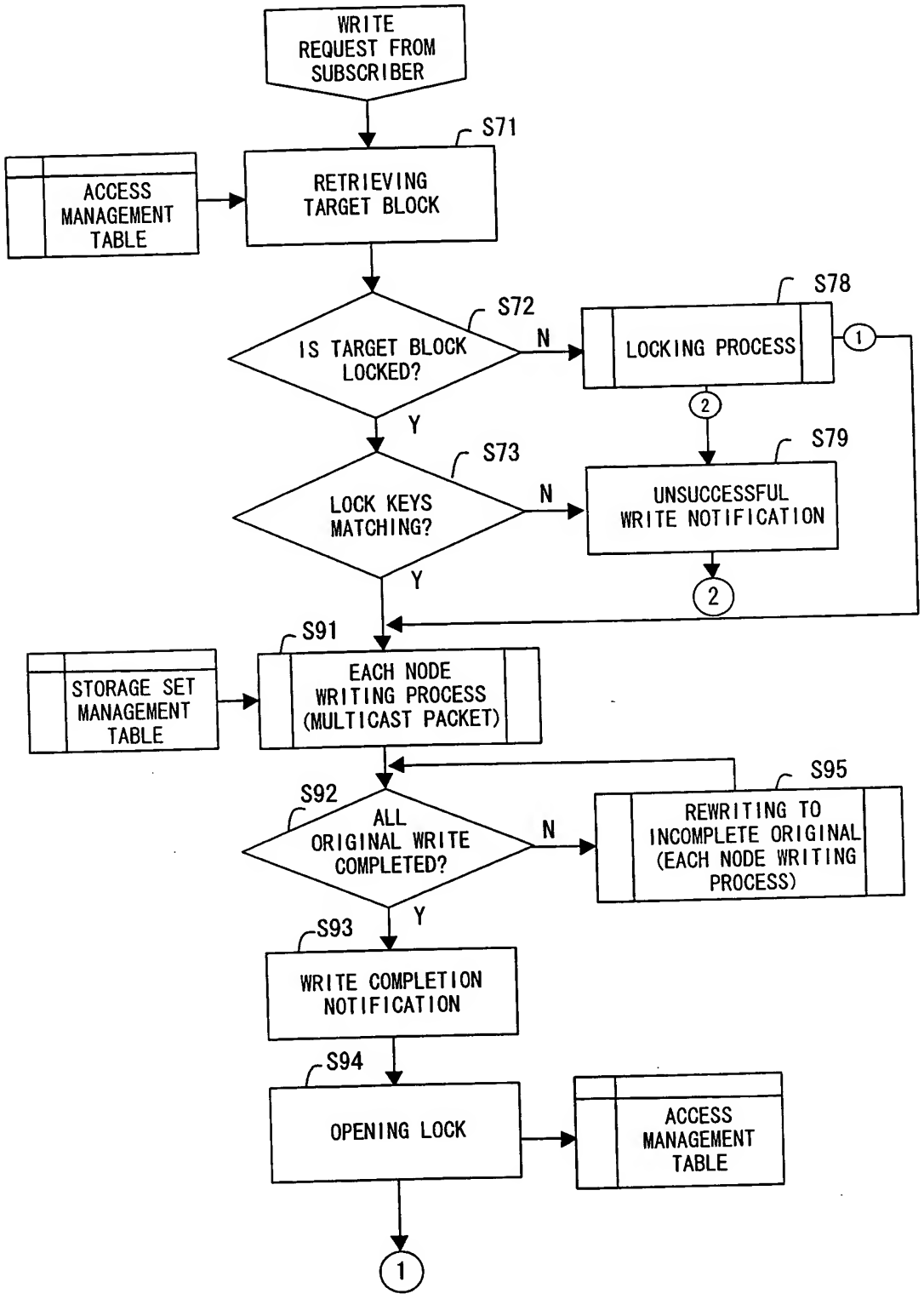
WRITE REQUEST FROM SUBSCRIBER
S71
ACCESS MANAGEMENT TABLE
RETRIEVING TARGET BLOCK
S72
IS TARGET BLOCK LOCKED?
N
S78
LOCKING PROCESS
1
2
Y
S73
LOCK KEYS MATCHING?
N
S79
UNSUCCESSFUL WRITE NOTIFICATION
2
Y
S91
STORAGE SET MANAGEMENT TABLE
EACH NODE WRITING PROCESS (MULTICAST PACKET)
S95
S92
ALL ORIGINAL WRITE COMPLETED?
N
REWRITING TO INCOMPLETE ORIGINAL (EACH NODE WRITING PROCESS)
Y
S93
WRITE COMPLETION NOTIFICATION
S94
OPENING LOCK
ACCESS MANAGEMENT TABLE
1

FIG. 24

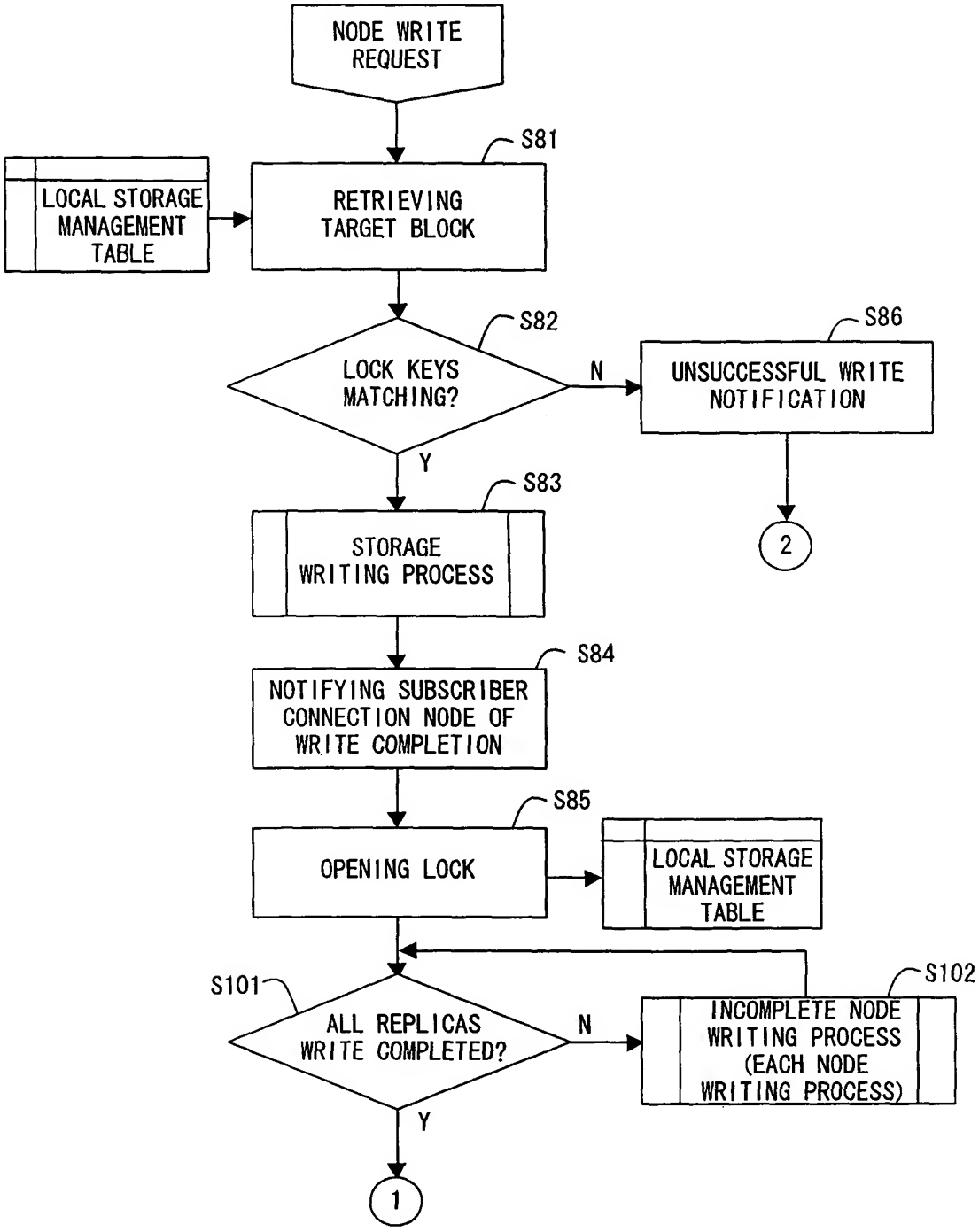
NODE WRITE REQUEST
S81
LOCAL STORAGE MANAGEMENT TABLE
RETRIEVING TARGET BLOCK
S82
LOCK KEYS MATCHING?
N
S86
UNSUCCESSFUL WRITE NOTIFICATION
Y
S83
STORAGE WRITING PROCESS
2
S84
NOTIFYING SUBSCRIBER CONNECTION NODE OF WRITE COMPLETION
S85
OPENING LOCK
LOCAL STORAGE MANAGEMENT TABLE
S101
ALL REPLICAS WRITE COMPLETED?
N
S102
INCOMPLETE NODE WRITING PROCESS (EACH NODE WRITING PROCESS)
Y
1

FIG. 25

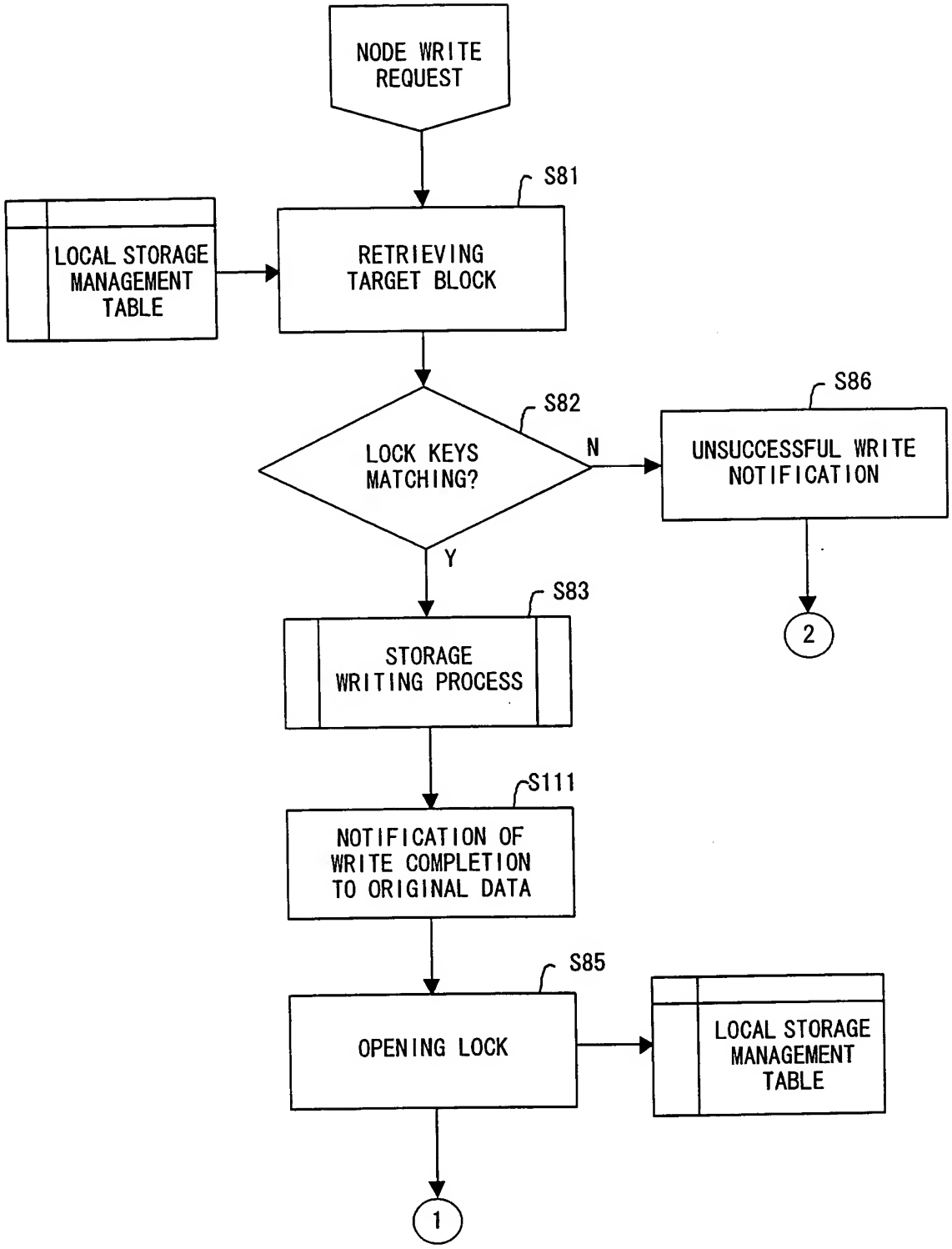
NODE WRITE REQUEST
S81
LOCAL STORAGE MANAGEMENT TABLE
RETRIEVING TARGET BLOCK
S82
LOCK KEYS MATCHING?
N
S86
UNSUCCESSFUL WRITE NOTIFICATION
2
Y
S83
STORAGE WRITING PROCESS
S111
NOTIFICATION OF WRITE COMPLETION TO ORIGINAL DATA
S85
OPENING LOCK
LOCAL STORAGE MANAGEMENT TABLE
1

FIG. 26

NODE	USER A			USER E			USER E		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	—	16.3	2	—	∞	0	—
D	9.1	3	d	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2	a	13.0	1	a'	10.9	3	a'
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 27

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a'	16.3	2	a'	∞	0	a'
D	9.1	3	d'	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2	a'	13.0	1	a'	10.9	3	a'
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 28A

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a	16.3	2	—	∞	0	a
D	9.1	3	d'	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2	a'	13.0	1	a'	10.9	3	a'
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 28B

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	—	17.8	2	—	11.3	2	—
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a	16.3	2	a	∞	0	a
D	9.1	3	d'	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2	a'	13.0	1	a'	10.9	3	a'
G	11.0	1	d	10.8	2	d'	8.4	3	d

FIG. 29

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a	16.3	2	a	∞	0	a
D	9.1	3	d'	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2	a'	13.0	1	a'	10.9	3	a'
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 30A

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a	16.3	2	a	∞	0	a
D	9.1	3	d'	17.0	1	d'	21.0	1	d'
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2		13.0	1		10.9	3	
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 30B

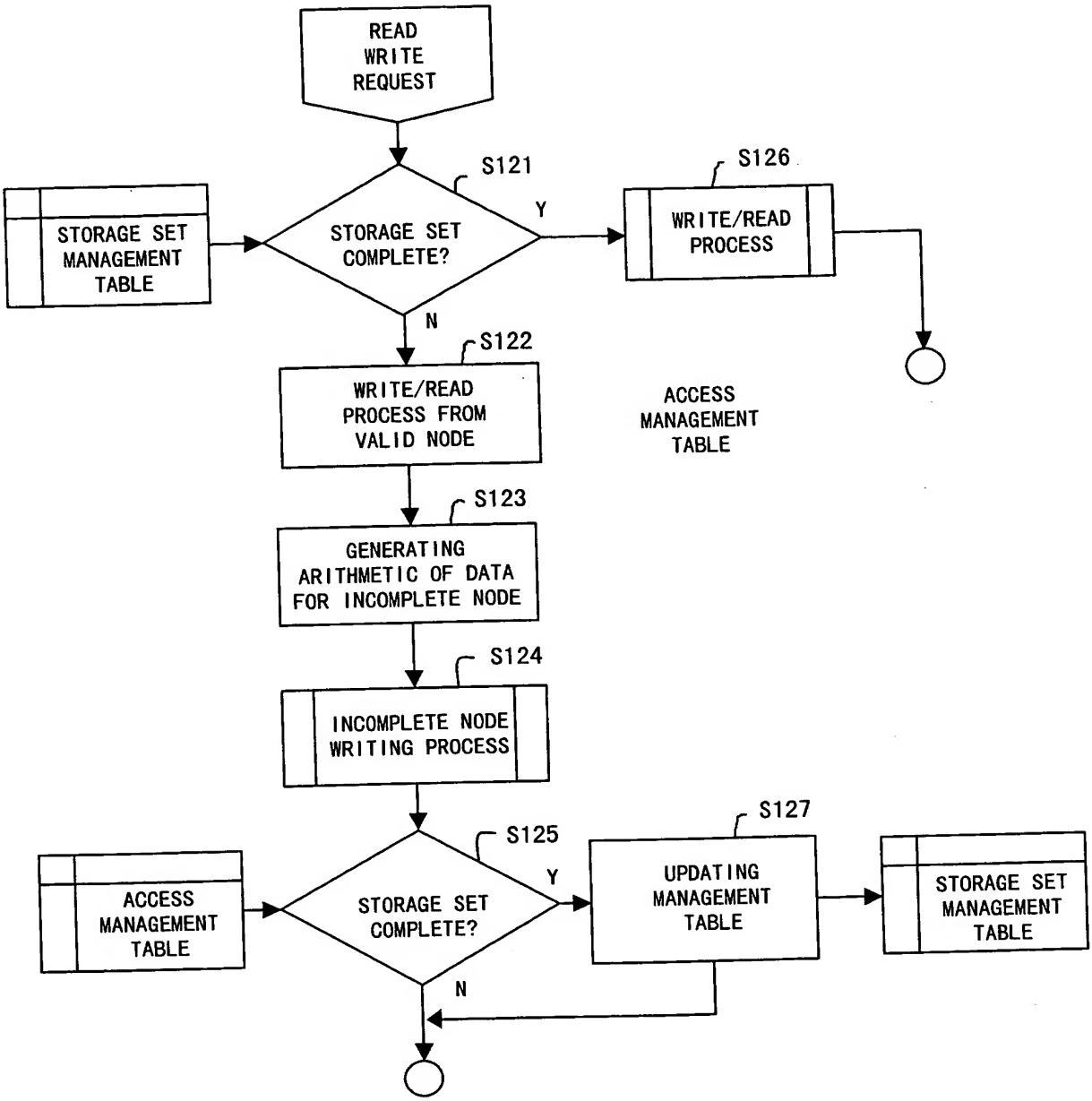
READ WRITE REQUEST
S121
STORAGE SET COMPLETE?
Y
N
STORAGE SET MANAGEMENT TABLE
S126
WRITE/READ PROCESS
S122
WRITE/READ PROCESS FROM VALID NODE
ACCESS MANAGEMENT TABLE
S123
GENERATING ARITHMETIC OF DATA FOR INCOMPLETE NODE
S124
INCOMPLETE NODE WRITING PROCESS
S125
STORAGE SET COMPLETE?
Y
N
ACCESS MANAGEMENT TABLE
S127
UPDATING MANAGEMENT TABLE
STORAGE SET MANAGEMENT TABLE

FIG. 31

NODE	USER A			USER E			USER C		
	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME	EVALUATION VALUE	HOP COUNT	VOLUME
A	∞	0	a	17.8	2	a	11.3	2	a
B	11.0	1	b	24.0	1	b	17.0	1	b
C	10.8	2	a	16.3	2	a	∞	0	a
D	9.1	3		17.0	1		21.0	1	
E	11.5	2	c	∞	0	c	14.8	2	c
F	8.3	2		13.0	1		10.9	3	
G	11.0	1	d	10.8	2	d	8.4	3	d

FIG. 32

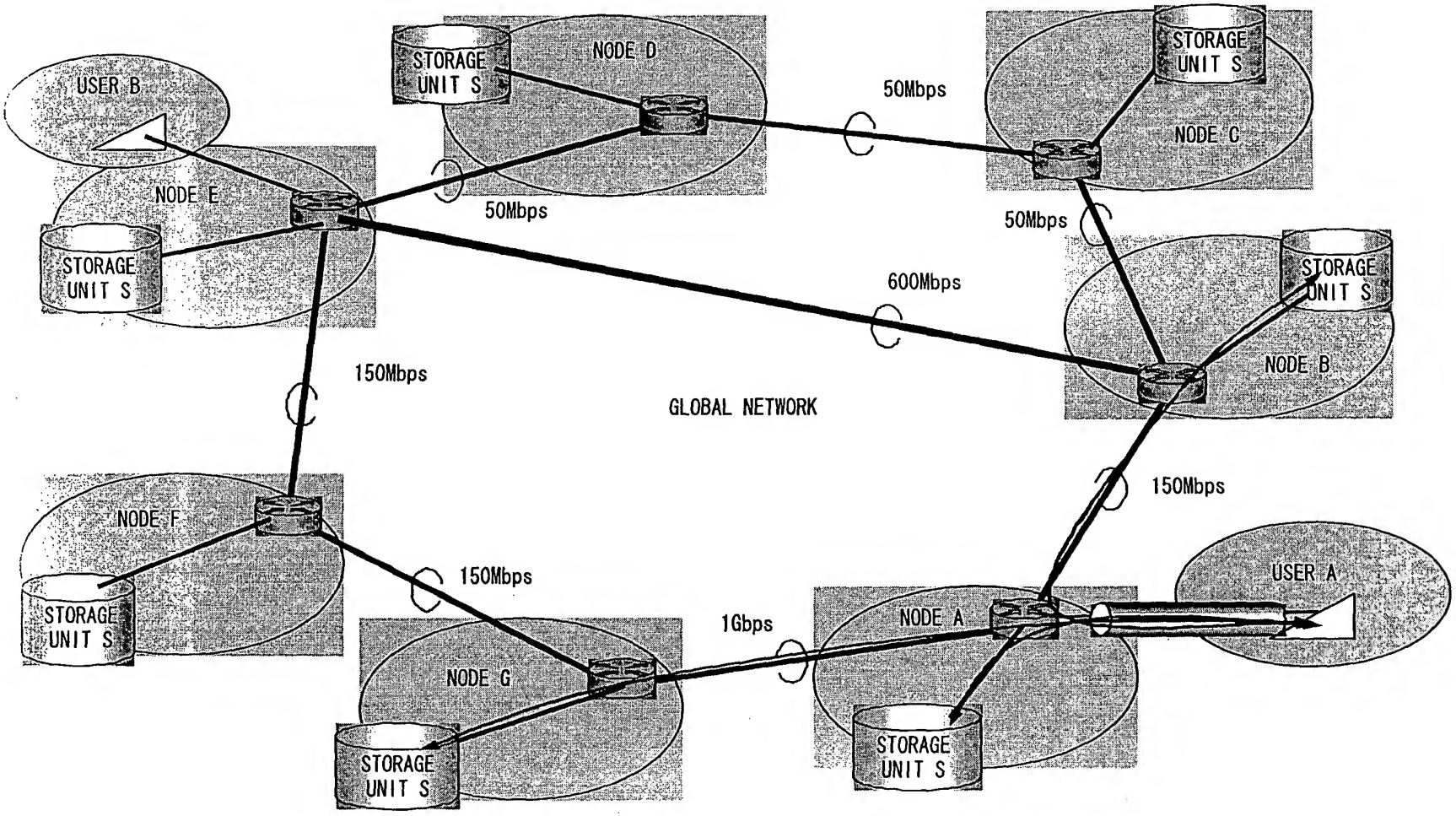
USER B
NODE E
STORAGE UNIT S
STORAGE UNIT S
NODE D
50Mbps
STORAGE UNIT S
NODE C
50Mbps
50Mbps
600Mbps
STORAGE UNIT S
NODE B
150Mbps
GLOBAL NETWORK
150Mbps
NODE F
STORAGE UNIT S
150Mbps
USER A
1Gbps
NODE A
NODE G
STORAGE UNIT S
STORAGE UNIT S

FIG. 33